T-splines 3 ways

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Class Overview

- Basic overview of T-Splines
- Best Applications for T-Splines in your workflows
- Beginner, intermediate, and advanced T-Spline workflows
- How to troubleshoot T-Splines
- How to ensure clean surfaces for conversion to BREP
Entry Level T-Splines

Working with Simple Surfaces, and Primitives

- Learn how to use simple surfaces for blending organic and orthogonal design together
- How to use edit form as the heart of your T-Splines workflow
- Basic principles of overmodelling
Intermediate T-Splines

How to get smarter with T-Spline surfaces

• Advanced features of edit form
• How to use subdivision and modification tools to T-Splines
• Modelling with reference geometry
• Box mode
Advanced T-Splines

Learn how to edit your generative design results and work with the data

• How to model an object from scratch
• How to use insert points for complex surfaces
• How to analyze t-spline surfaces for cleanliness
• Healing and troubleshooting surfaces
What are T-Splines?
How do T-Splines Work?

- A **T-spline** surface can be thought of as a **NURBS** surface for which a row of control points is allowed to terminate without traversing the entire surface. The control net at a terminated row resembles the letter "T". Modeling surfaces with T-splines can reduce the number of control points in comparison to NURBS surfaces and make pieces easier to merge, but increases the book-keeping effort to keep track of the irregular connectivity. T-splines can be converted into NURBS surfaces, by knot insertion, and NURBS can be represented as T-splines without T's or by removing knots.

- TL;DR – T-Spline is inherently different maths at the back end. Treat it accordingly! T-Splines are very complex!
If you are new to T-Splines, the method of modelling is very different to what you are accustomed to in the design space of Fusion 360, it's best to treat it like learning a new program! Little of what you are accustomed to in CAD will translate over to T-splines.
Approach

- You will get the most out of T-Splines if you treat it like modelling with Clay.
- You shouldn’t try and jump straight into adding details from the beginning! You will take multiple passes at the overall geometry to arrive at the final object.
Essential Tools
**Edit Form**

- The most important tool when editing t-Spline geometry in Fusion 360
- Critical functions
  - Selection options
  - Soft modification
  - Selection Filters
- Quick access to display modes
Selection Options

- Selection options are hugely valuable to the t-splines workflow
  - As you are working with lots of faces and soft organic forms, the selection tools make life easier when needing to do specific functions to specific areas
- Each function in selection options has its own behavior, with different application
- In this example, one face was selected and then grow is used to expand to each face in proximity
Soft Modification

- When you select a face and move in T-Splines, you are editing that face only. This can make creating smooth transitions from one feature to another a challenge.

- Soft modification adds an “area of effect” to your selection, to create a smooth fall off from the edited surface, to the rest of the surface.

- Soft modification can operate in a circular function, a specific face count, or in a linear U or V direction.

- In this example, one face is selected, using the distance area of effect, with a smooth transition across the area of effect. You can see this demonstrated by the gradient of red to white across the selection area.
Selection Filters

- Sometimes you don’t want to be able to pick anything, you need that finer control
- Selection filters in T-Splines operate the same way as they do in the Model space
- Each selection filter will make only that specific function selectable
- In this example, the filter is set to vertex, which makes faces and edges unselectable
- This is particular useful when needing to make finer controls over a large high face count surface
- NOTE: the vertex selection mode makes all vertexes visible with a point for ease of use
Exercise 1: the basics
How to use primitives

- **Box** – it’s a…box
- **Plane** – create a flat plane against any surface or construction plane
- **Cylinder** – this uses a collapsed star to close itself. Take note as this may cause you challenges down the line
- **Sphere** – created with a closed point
- **Torus** – mmmmmm, donuts
- **Quadball** – like a sphere, but has quad faces all over, so no collapsed faces!
- **Pipe** – it’s a pipe, but it’s open!
Replace Face

• In the model space, it is possible to replace a face, and rebuild the entire geometry with a surface you created in T-Splines!
• When you combine this with overmodelling principles in T-Splines, you can very rapidly bring orthogonal and organic designs together!
Exercise 2: Getting Schwifty
Complexity Tools
Display Modes

- Display mode shows you what’s happening “under the hood” with T-Splines.
- T-Splines are made by the net surrounding the object to create smooth grids.
- As a result, when viewing in smooth mode only, you may make changes that seem acceptable, until you look at the box mode and see self-intersecting elements.
- This geometry will calculate and convert to BREP, but as a result of this underlying issue, you may run into challenges with other modifications to the geometry down the line.
- It is always worth switching back and forth from box to smooth to ensure clean geometry.
Pull Tool

- Pull enables you to snap geometry to Sketch lines or other Geometry
- There are 2 core modes, Auto, and Select Targets
  - Only lazy people use Auto :P
  - Make sure you set your targets first and vertices after, as it will give you a better idea of what's going to happen
- The pull function is “black box”
  - If you need dimensionally exact geometry, you can do this with match (separate tool)
Insert Edge

• You are not limited to the face count you started with.
• You can add as many edge divisions and complexity as you like
• NOTE: Like most surface modification tools in T-Splines, they do not operate with absolute dimensions, rather they are a function of an integer. Their distance is measured from 0-1 with .5 being the middle (as it should be, duh.)
• Insertion can be simple, or exact
  o Simple: adds the edge line, without preserving the geometry as it currently exists (you will see the geometry shift)
  o Exact: adds the edge line, and automatically subdivides and adds complexity as necessary, to maintain the surface continuity already in place
• Insert edge adds an surface division along the U OR V lines
Exercise 3: Master of your Domain
Empty your mind, be formless, shapeless — like water. Now you put water in a cup, it becomes the cup; You put water into a bottle it becomes the bottle; You put it in a teapot it becomes the teapot. Now water can flow or it can crash. Be water, my friend.
Intuitive Reason

• When building elements from scratch in T-Splines, you will hybridise direct modelling workflows with abstract modelling workflows
• Overmodelling techniques will be applied *liberally*
• You will combine a plethora of different tools in different ways to achieve your target geometry
• Always make reference geometry to ensure your design is within specifications of your project
• Don’t treat any t-spline geometry as “precious” if it doesn’t work, delete the trouble area and rebuild it, it doesn’t take as long as you might think!
• T-Splines is fluid, try to be fluid too!
Timeline Behavior

- T-Splines will carry the timeline "snapshot" with it
- This means that irrespective of where the T-Spline was created in the timeline, it will switch to the T-Spline workspace based on where your timeline header is
- This is useful when fleshing ideas out and then reforming them as a product develops
- T-Splines ARE NOT parametric
- T-Splines work seamlessly with BREP Geometry
Repair Body

- An idea T-Spline is made exclusively of 4 sided faces
- During the process of adding complexity and detail to your model, you may unintentionally create Ngons, T Points, L Points, or Star Points
- These aren’t inherently bad, but if left unchecked, will cause complications down the line
- Ngon – any T spline face more than 4 sides
- T Point – where 2 faces only meet 1, creating a T edge pattern instead of a cross
- L Point same as above, but creates an L intersection
- Star Points – where multiple faces all connect to a single point, creating a star shape pattern of vertices
Smoothing

• Does exactly what it says on the tin!
• Smooth operates by averaging each surface against the surface adjacent to it, creating a smoother surface continuity as a result
• Based on this method, smoothing is calculated as an integer between 0 and 1 (no smooth, to smoothest possible)
• This function can be run multiple times in order
• This function will effect your GD parts structural integrity to a small degree. Run FEA after if using this to guarantee part is suitable for use
Quick Summary

- Work in multiple passes, do not dive straight into detail modelling
- Frequently switch between smooth and box mode to see how the geometry health is
- Don’t forget to check the state of your body with Auto-Repair
- Soft modification is a life saver, use it often!
- The selection filters are important
- Always overmodel
- Don’t be precious with the geometry
- Take your time, it’s an entire extra CAD package built right into Fusion 360!
Next Steps

- Try these Next!
  - **Match** – matches a T-Spline edge to a sketch or surface edge
  - **Bevel edge** – the “chamfer” of the T-Spline space
  - **Slide edge** – need to adjust a chain but don’t want to add a whole new one
  - **Interpolate** – switch the control points and surfaces, can be useful for fitting object to other surfaces, or to exaggerate the features of a sculpt
  - **Subdivide** – split a T-Spline face into 4 faces, a quick and easy way to start implanting detail
Thank You!